QWD48 **Simultaneous measurement of atomic position and momentum**

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We have considered a measurement scheme for atoms in which both position and momentum are simultaneously measured, subject to the constraints of the uncertainty principle. In this scheme we consider a beam of 3-level atoms in a V configuration; one transition is resonant with a standing cavity field, and the other is resonant with a traveling wave (see Figure 1.). After an atom has passed through these fields the phases of the fields are measured. If only the standing wave were used we could use this information to make a very precise determination of the position of the atom [1,2], and similarly with only a traveling wave we could determine the momentum very accurately [3]. The uncertainty principle tells us that we cannot measure both position and momentum simultaneously beyond a certain accuracy [4]. We describe how the competition between the two kinds of measurement processes enforces the uncertainty principle.

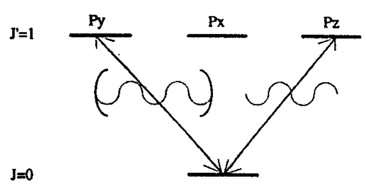

Figure 1. Energy level diagram for the atoms used in our measurement scheme. One transition is driven by a standing wave, and the other by a running wave. The change in phase of these waves after the passage of an atom through the apparatus gives information on the position and momentum of the atom respectively.

References
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15:00-16:30 **HALL 13/14**
QWE - Nonlinear Interactions I
Presider: A. Politi, *INO Florence, Florence, ITALY*

15:00
QWE1 **Break up of Spatial Solitons by Cascading**

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All-optical switching and routing of light is a topic of intense investigation due to their potential important applications to ultrafast signal processing devices. Optical solitons, both temporal and spatial are specially well suited for such purpose due to their unique properties. Under appropriate conditions, the propagation of light in cubic nonlinear media is described by the nonlinear Schröedinger equation (NLSE) which has both single and higher-order soliton solutions, and various types of devices based on such solitons have been proposed. However, solitons (more properly, solitary waves) also form in quadratic nonlinear media, and they have been observed experimentally in second-harmonic generation settings in KTP and $LiNbO_3$ crystals.[1] In this communication we show the principle of operation of a switching device based on the formation of spatial solitons in a planar waveguide made of a quadratic nonlinear material. We show numerically that under appropriate conditions the input beams launched in the waveguide either excite a single spatial soliton or they break apart into several solitons that emerge propagating in different directions. The transition from a single to a multiple branch output is governed by a digital change in the amplitude of the input beam.

We study a second-harmonic generation configuration, so that the spatial solitons in the quadratic medium form by the mutual trapping of the fundamental and second harmonic beams. At large values of the phase mistmatch between the waves, conversion to the second harmonic is small and the equations that describe the wave evolution can be viewed as a Hamiltonian deformation of the NLSE.[2] Single solitons are robust against such deformations, so that input beams corresponding to single solitons of the NLSE propagate without significant changes. However, the perturbations to the NLSE posed by the parametric wave mixing and linear walk-off between the interacting waves destroy the higher-order solitons. Higher-order solitons are bound states of single solitons, so that input beams, corresponding to higher-order solitons of the NLSE, break up into various beams with different transverse velocities. Hence, they emerge in different directions. In summary, the excitation of a single soliton produces a single output whereas fission of larger amplitude beams leads to a multiple branch output.

In this paper we report the results of our comprehensive numerical investigation of the beam fission proces. We study the number and velocities of the emerging solitons, as a function of the phase mismatch, walk-off and input beam intensities. We use both numerical techniques and the tools provided by the *Inverse Scattering Transform*. We discuss the similarities of the fission of beams that we describe and the fission of temporal solitons in cubic media in the presence of various perturbations to the NLSE, such as filtering or third-order dispersion.[3] We eventually discuss the experimental scenario required to observe our predictions, and their potential applications to the realization of an all-optical thresholding device.

References
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